



Service Data

RHS0043

Steering Assist System

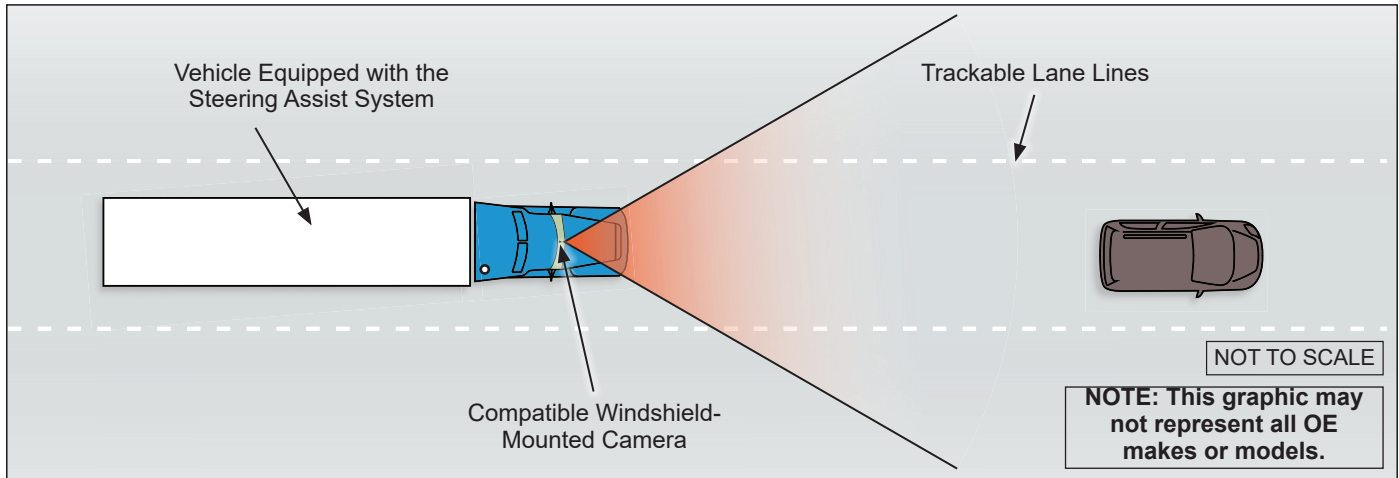


Figure 1 – The Steering Assist System Uses a Windshield-Mounted Camera

⚠ WARNING

Sheppard safety technologies complement safe driving practices. No commercial vehicle safety technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.

DESCRIPTION

The Steering Assist System is a driver assistance system that integrates with braking systems, the vehicle itself, and select, compatible third-party components.

The Steering Assist System combines unique steering technology with a forward-facing camera for active lane identification. Steering Assist is built on the R.H. Sheppard Co. Inc. HD94™ or MD83™ steering gear, which offers a quick steering ratio for less steering wheel turns, ideal for large wheelbase vehicles.



Figure 2 – System Components*

*Components may vary depending on the system installed on the vehicle. Contact the vehicle manufacturer for more information.

Additional Reference Information on RSHppard.com

- For vehicle operation, refer to RHS0044, Steering Assist System Operator's Manual.
- Refer to RSHppard.com for product and diagnostic support.



GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following guidelines should be observed **AT ALL TIMES**:

- ▲ Park the vehicle on a level surface, apply the parking brakes and always block the wheels. Always wear personal protection equipment.
- ▲ Stop the engine and remove the ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically-charged components.
- ▲ Do not attempt to install, remove, disassemble or assemble a component until you have read, and thoroughly understand, the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
- ▲ If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system, a Bendix® DRM™ dryer reservoir module, a Bendix® AD-9si®, AD-HF®, or AD-HFI® air dryer, be sure to drain the purge reservoir.
- ▲ Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- ▲ Never exceed manufacturer's recommended pressures.
- ▲ Never connect or disconnect a hose or line containing pressure; it may whip and/or cause hazardous airborne dust and dirt particles. Wear eye protection. Slowly open connections with care, and verify that no pressure is present. Never remove a component or plug unless you are certain all system pressure has been depleted.
- ▲ Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, wiring, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
- ▲ Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
- ▲ Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
- ▲ For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.
- ▲ The power **MUST** be temporarily disconnected from the radar sensor whenever any tests **USING A DYNAMOMETER** are conducted on a vehicle equipped with a Bendix® Wingman® system.
- ▲ You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.



WARNING

Improper use of the Steering Assist System can result in a collision resulting in property damage, serious injuries, or death. Be sure to read, understand, and carefully follow the instructions in this document.



WARNING

Due to the inherent limitations of image recognition technology, camera-based safety technology — on rare occasions — may not be able to detect or may misinterpret lane markings. Examples may include — but are not limited to — lane marking width, lane marking color(s), lane marking location from center, and road conditions where lane markings are applied. At these times, alerts may not occur, or erroneous alerts may occur.



WARNING

Sheppard safety technologies complement safe driving practices. No commercial vehicle safety technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.



IMPORTANT

It is the responsibility of the driver to always keep their hands on the steering wheel and to remain vigilant and change driving practices depending on traffic and road conditions.



WARNING

This product may expose you to chemicals including nickel, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to P65Warnings.ca.gov.



WARNING

The Steering Assist Electronic Control Units (ECUs) are not designed to store data for purposes of accident reconstruction, and Bendix® ACom® Diagnostic Software is not intended to retrieve data for purposes of accident reconstruction. Sheppard makes no representations as to the accuracy of data or video retrieved and interpreted from ECUs for purposes of accident reconstruction. Sheppard does not offer accident reconstruction services or interpretation of stored data. Steering Assist ECUs are not protected from fire, loss of power, impact damage, or other conditions that may be sustained in a crash situation and may cause data to be unavailable or irretrievable.

SYSTEM FEATURES

LANE KEEP ASSIST (LKA)

(In conjunction with a forward-facing windshield-mounted camera)

- May detect lane markings and evaluate relative vehicle position
- May recognize when the vehicle begins to drift towards the lane markings
- May distinguish between planned lane changes and lane drifting
- May intervene before the vehicle reaches the lane markings
- May automatically apply a gentle correction torque to the steering wheel
- May smoothly release steering torque as soon as the vehicle position within the lane markings is reestablished
- LKA may become active at 37 mph/60 kph
- If equipped, the driver may use the disable switch to override or suppress LKA-applied steering wheel torque; this feature may be useful when driving on roads with inconsistent lane markings that can cause excessive false warnings. Examples would include construction zones, poorly marked lanes, or missing lane markings. The system alerts will automatically become available again after 15 minutes or if the disable switch is pressed a second time. Refer to the vehicle operator's manual for enabling/disabling LKA.

STEERING ASSIST

Speed-dependent Steering Assist may provide variable steering assist based on vehicle speed to potentially help the driver experience easier steering response at low speeds and a firmer steering response at high speeds. When applicable, the vehicle is equipped with steering profiles that the driver can adjust for their preference. Refer to the vehicle operator's manual for more information.



There is no activation on/off switch for the speed-dependent steering assist feature. The driver should always drive normally and safely, and is responsible for the safe operation of the vehicle.

Active Return may return the steering wheel to near center position at lower speed maneuvers.



There is no activation on/off switch for the active return feature. The driver may override this feature by applying additional steering input force. The driver should always drive normally and safely.

Road Disturbance Compensation may reduce steering wheel vibration typically caused by road disturbances like potholes, road debris, and other rough road conditions.



There is no activation on/off switch for the road disturbance compensation feature. The driver should always drive normally and safely, and is responsible for the safe operation of the vehicle.

SYSTEM COMPONENTS

STEERING ANGLE SENSOR (SAS)

- The Steering Angle Sensor (SAS) reports the steering wheel position through a serial communication link or CAN network. See Figure 3.



Figure 3 – Steering Angle Sensor (SAS)

FORWARD-FACING CAMERA

Components, like a windshield-mounted camera, may vary depending on the system installed on the vehicle. Check with the vehicle manufacturer for more information.

- The forward-facing camera may track the lane markers and provide the lane characteristics for the left and right marker to the Steering Assist System over the vehicle communication network. In addition, the system also may provide information on when the lane departure warnings will be suppressed, allowing the Lane Keep Assist (LKA) feature to be suppressed at the same time.

WINDSHIELD CAMERA MOUNTING BRACKET

- When applicable, the windshield bracket holds the camera secure and keeps it facing the correct direction to help to successfully determine lane width and position. See Figure 4.

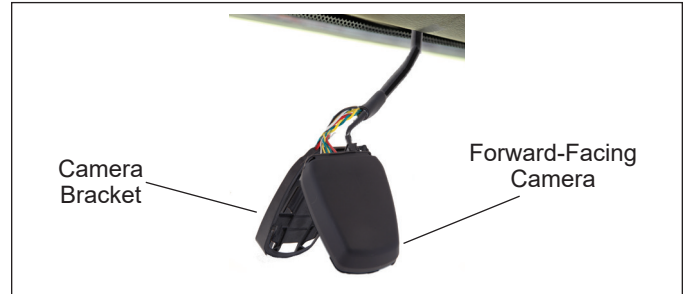


Figure 4 – Forward-Facing Camera & Bracket Example

STEERING ASSIST ECU

- The Electronic Control Unit (ECU) for the Steering Assist System is a standalone unit designed to work with J1939 Vehicle CAN and applicable system components. See Figure 5.

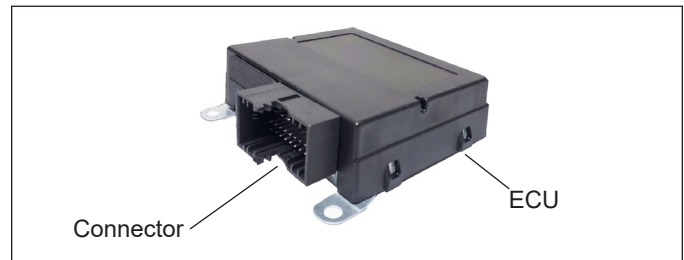


Figure 5 – Steering Assist Electronic Control Unit (ECU)

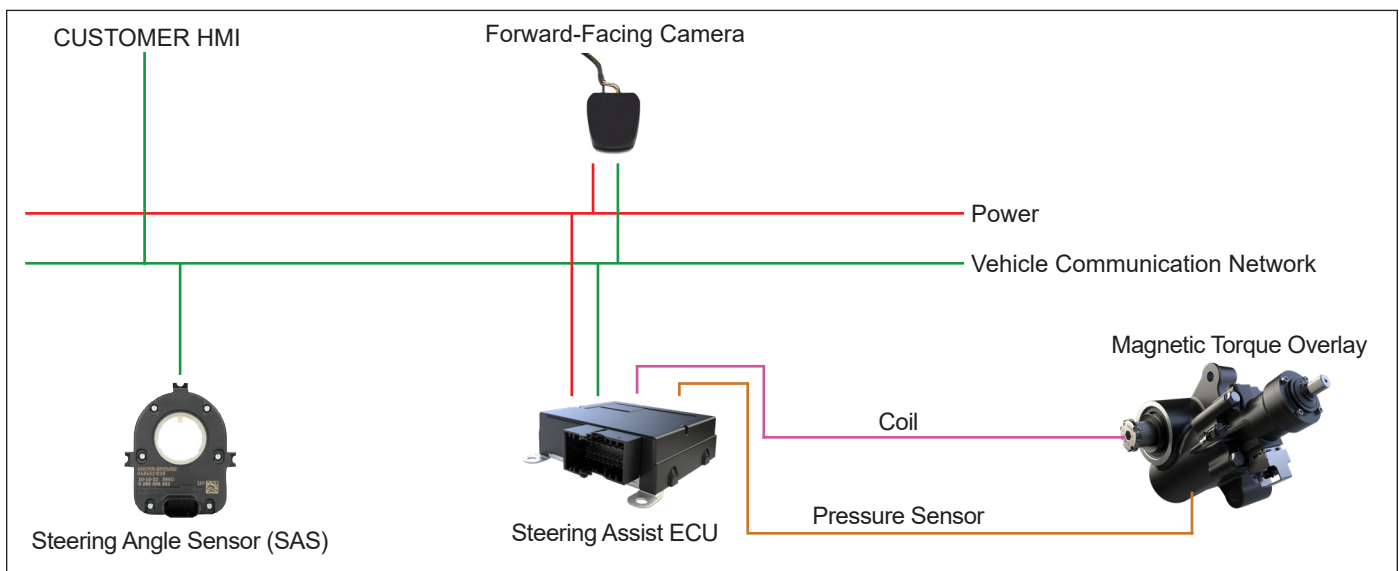


Figure 6 – Steering Assist System Schematic Example

MAGNETIC TORQUE OVERLAY POWER STEERING GEAR

- The Magnetic Torque Overlay power steering gear enables hydraulic steering. For additional service and troubleshooting information, *refer to the Sheppard™ D-Series Integral Power Steering Gear manual on rshppard.com.*

TROUBLESHOOTING

Read and follow the General Safety Guidelines shown on Page 2 of this document.



All vehicle Diagnostic Trouble Codes (DTCs) related to the engine; transmission; instrument cluster; engine cruise control; electronic braking systems with features such as ABS, ATC, ESC; collision mitigation systems; or third-party components, must first be resolved – with no DTCs present during the vehicle operation while in cruise control – prior to running Bendix® ACom® Diagnostic Software to resolve Steering Assist System DTCs.



If a problem with the Steering Assist System is detected, it should be serviced as soon as possible to restore full functionality. The Lane Keep Assist (LKA) feature may be deactivated.

BENDIX® ACOM® DIAGNOSTIC SOFTWARE

Bendix® ACom® Diagnostic Software is a PC-based software program available to purchase from Bendix.com. This software provides the technician with access to all the available Electronic Control Unit (ECU) diagnostic information and configuration capability. For controller-specific system diagnostics, use a current version of the ACom Diagnostic Software.

READING AND CLEARING DIAGNOSTIC TROUBLE CODES (DTCs)



All vehicle Diagnostic Trouble Codes (DTCs) related to the engine; transmission; instrument cluster; engine cruise control; electronic braking systems with features such as ABS, ATC, ESC; collision mitigation systems; or third-party components, must first be resolved – with no DTCs present during the vehicle operation while in cruise control – prior to running Bendix® ACom® Diagnostic Software to resolve Steering Assist System DTCs.

For assistance with Bendix ACom Diagnostic Software, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725).

STEERING ANGLE SENSOR (SAS) AND LANE KEEP ASSIST (LKA) DIAGNOSTIC TESTING

1. Determine if there are any active driver alerts on the driver display. Specifically check if the *Check Steering Electronic Control Unit (ECU)* alert is active. Refer to vehicle operator's manual as dash and instrument cluster layout may differ.
2. Connect a laptop to the tractor's diagnostic port and use Bendix® ACom® Diagnostic Software to generate a DTC report. After generating the DTC report, perform the following:
3. Check the calibration of the Steering Angle Sensor (SAS) using ACom Diagnostic Software.
 - If the calibration is not accurate, the SAS needs recalibrated.
 - Before performing the recalibration, document the amount by which the SAS is out of calibration.
4. Verify through Bendix ACom Diagnostic Software that there are no active Diagnostic Trouble Codes (DTCs). Using safe driving practices, drive the vehicle under normal conditions to confirm the vehicle operation is consistent with the operator's manual.

IGNITION VOLTAGE TEST

- **Ignition Voltage Too Low:** Measure the ignition voltage under load. Ensure that the ignition voltage is greater than 9 VDC (Volts DC). Check the vehicle battery and associated components. Inspect for damaged wiring, damaged or corroded connectors, and loose connections. Check the condition of the fuse.
- **Ignition Voltage Too High:** Measure the ignition voltage. Ensure that ignition voltage is not greater than 16 VDC. Check the vehicle battery and associated components. Inspect for damaged wiring, damaged or corroded connectors, and loose connections.

POWER SUPPLY TESTS

1. Take all measurements at the Electronic Control Unit's (ECU's) harness connector.
2. Measure the supply voltage with a multimeter. The supply voltage on Pin 1 to ground should measure between 10 to 16 Volts DC (VDC).
3. Check for damaged wiring, damaged or corroded connectors, and loose connections.
4. Check the condition of the vehicle battery and associated components. Ensure the connection to ground is secure and tight.
5. Using the procedures described by the vehicle manufacturer, check the alternator output for excessive noise.

COMMUNICATIONS (J1939) TEST AND TROUBLESHOOTING PROCEDURES

The Steering Assist System requires several J1939 messages from various Electronic Control Units (ECUs). The system will set a Diagnostic Trouble Code (DTC) if one of the messages from one of the expected ECUs is not present.

1. Take all measurements at the harness connector unless otherwise indicated.



Do not insert any probe into the pin on the mating connector of the sensor that is greater than the width of a terminal. Damaged connector pins will require the replacement of the harness.

2. Unplug the Steering Assist ECU harness. With the ignition switch off, measure the resistance (ohms) using a multimeter between harness pins 10 and 11. The reading should be approximately 60 ohms. If it is not, the vehicle wiring should be investigated.
3. Check for damaged or reversed J1939 wiring. If the J1939 HIGH, or J1939 LOW wiring circuits are damaged, such as shorting together, the entire J1939 link will be lost. The problem may be intermittent, enabling the J1939 link to operate normally sometimes. If this occurs, multiple diagnostic trouble codes will be logged in multiple engine and vehicle controllers, as well as the camera and radar. If the J1939 HIGH, and J1939 LOW, wiring circuits are reversed, communication over the entire J1939 link will be lost. Devices that use the affected network will not be able to transmit or receive messages on that network.

4. Check for corroded or damaged wiring connector problems such as opens or shorts to voltage or ground. If the connector terminals are corroded, this may be an indication of water intrusion into the wiring system. Replacement of the entire harness is recommended. If the terminals of the Steering Assist ECU, coil, or pressure are corroded, replacement of the sensor/ ECU is recommended.
5. Check for other J1939 devices which may be inhibiting J1939 communication. The service technician should consult the vehicle manufacturer's procedures for other J1939 troubleshooting procedures. The device's power should be removed and measurements made at the ECU pins for shorts to ground and power pins and resistance between the J1939 HIGH or J1939 LOW input circuits.

! IMPORTANT

If replacing the steering gear, a new Electronic Control Unit (ECU) will also need to be installed. ECUs are VIN and gear serial number specific.

After installing a new ECU on the Steering Assist System, a set of calibration procedures must be completed in the Bendix® ACom® Diagnostic Software.

Reference TCH-025-002, Bendix® ACom® PRO™ Diagnostic Software Procedures for New Electronic Control Unit (ECU) Installation, on B2Bendix.com for additional information.

IDENTIFYING GEAR SERIAL NUMBER BY PHYSICAL LABEL

Every Magnetic Torque Overlay steering gear has a label on the gear housing. This label contains 3 rows of gear information, as well as a data matrix that is unique to every gear.

The gear serial number is 8 digits of characters on the 2nd row of the label.

Please visit rhsheppard.com for additional ways to identify the gear serial number.



Figure 7 – Steering Gear Label Example

IDENTIFYING GEAR SERIAL NUMBER WITH ACOM DTC REPORT

Navigate to the component information section of the DTC report. Locate the Steering Assist section. This is usually at the end of an ACom DTC report. The steering gear serial number is displayed at the end of the Steering Assist section.

DIAGNOSTIC TROUBLE CODE (DTC) TABLE



The Steering Assist System relies on the proper operation of other components on the vehicle. If there are faults in any other system on the vehicle, the Steering Assist System may not operate properly.

SPN	FMI	Diagnostic Trouble Code (DTC)	Go to the Service Action Code List in Table 2
		Name	
70	9	J1939 Signal - CCVS1 CAN Time Out	F
70	19	J1939 Signal - Error in CCVS1 - Parking Brake Switch	G
190	9	J1939 Signal - EEC1 CAN Time Out	F
190	19	J1939 Signal - Error in EEC1 - Engine Speed	G
904	9	J1939 Signal - EBC2 CAN Time Out	F
904	19	J1939 Signal - Error in EBC2 - Front Axle Speed	G
1702	9	J1939 Signal - FLI2 CAN Time Out	F
1710	19	J1939 Signal - Error in FLI2 - Lane Tracking Status Left Side	G
1711	19	J1939 Signal - Error in FLI2 - Lane Tracking Status Right Side	G
1807	9	J1939 Signal - VDC2 CAN Time Out	F
1807	19	J1939 Signal - Error in VDC2 - Steering Wheel Angle	G
1808	19	CAN_OR_VDC2_YAW_RATE	G
1809	19	J1939 Signal - Error in VDC2 - Lateral Acceleration	G
1814	9	J1939 Signal - VDC1 CAN Time Out	F
1816	19	J1939 Signal - Error in VDC1 - ROP Engine Control active	G
1817	19	J1939 Signal - Error in VDC1 - YC Engine Control active	G
1818	19	J1939 Signal - Error in VDC1 - ROP Brake Control active	G
1819	19	J1939 Signal - Error in VDC1 - YC Brake Control active	G
2875	19	J1939 Signal - Error in OEL - Hazard Light Switch	G
2876	19	J1939 Signal - Error in OEL - Turn Signal Switch	G
3683	9	J1939 Signal - Error in SAS Time Out	F
3683	19	J1939 Signal - Error in SAS steering wheel angle	G
3689	19	J1939 Signal - Error in SAS Counter	G
3690	19	J1939 Signal - Error in SAS Checksum	G
5676	9	J1939 Signal - AEBS CAN Time Out	F
5676	19	J1939 Signal - Error in AEBS - Forward Collision Advanced Emergency Braking System State	G
5876	9	J1939 Signal - OEL CAN Time Out	F
9751	9	J1939 Signal - FLIC CAN Time Out	F
9751	19	J1939 Signal - Error in FLIC - Lane Keeping Assist Enable Command	G

Table 1 – Diagnostic Trouble Codes (DTCs)



The Steering Assist System relies on the proper operation of other components on the vehicle. If there are faults in any other system on the vehicle, the Steering Assist System may not operate properly.

SPN	FMI	Diagnostic Trouble Code (DTC)	Go to the Service Action Code List in Table 2
		Name	
9760	19	J1939 Signal - Error in FLIC - Requested Active Steering Driver Preference Mode	G
516222	2	ECU H Bridge - Not OK	C
516222	3	ECU H Bridge - Short to Battery	D
516222	4	ECU H Bridge - Short to Ground	D
516222	5	ECU H Bridge - Open load	D
516700	0	High Temperature of ECU	A
516701	3	Battery Voltage Above Threshold	B
516701	4	Battery Voltage Below Threshold	B
516702	5	Pressure Sensor - Open Circuit	H
516702	3	Pressure Sensor - Short Circuit	J
516707	31	System_Limited_Performance	F/G
516707	13	EOL Calibration not performed	E
516707	12	ECU Fault - Internal Error	K
516707	11	System No Performance	C
516708	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	F
516708	13	EOL Gear Parameters not programmed properly	M
516708	12	NVM failed to read or write	N
516709	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	F
516710	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	F
516711	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	F
516712	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	F
517554	2	Coil Implausible Data	D
517554	10	Coil Current - Out of Tolerance	D
517554	3	Short in coil connection	D
520196	2	Lane direction mismatch in camera	P
524032	5	J1939 Bus - Open or Short	F

Table 1 – Diagnostic Trouble Codes (DTCs)

SERVICE ACTION CODE TABLE

NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds.
DO NOT attempt to diagnose J1939 DTCs without the engine running.

NO DTC	The Steering Assist System is equipped with a dual integrated pressure sensor that reads pressure from the left and the right turn side of the hydraulic chamber of the steering gear. The Steering Assist Electronic Control Unit (ECU) uses the pressure signal from the pressure sensor to apply torque. If the pressure sensor wires are not in the correct pin locations, greater turning resistance may be felt in the steering wheel. <u>There will not be any Diagnostic Trouble Codes (DTCs) that set for this scenario.</u> To check for the proper wire orientation, verify that Pin 1 of the ECU is connected to Pin 4 of the pressure sensor, and Pin 2 of the ECU is connected to Pin 3 of the pressure sensor.
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Service Action Code	Recommended Service
A	<p>This DTC <i>may not</i> be an indicator of a malfunctioning ECU.</p> <p>Possible causes: Some error conditions may occur at extreme high or low temperatures. These DTCs must be diagnosed with the ambient temperature above 32°F (0°C) and below 100°F (38°C).</p> <p>Perform the following:</p> <ul style="list-style-type: none"> • Ensure ambient temperature is within operating range. • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>. • If the DTC is set to inactive and can be cleared by the above step, the ECU is functioning properly and the system can be returned into operation. • If the DTC stays active and is unable to be cleared, the ECU will need to be replaced.
B	<p>This DTC <i>may not</i> be an indicator of a malfunctioning ECU.</p> <p>Possible causes: These DTCs result from incorrect battery supply voltage or wiring harness issues as measured at the Steering Assist ECU.</p> <p>Review the following sections:</p> <ul style="list-style-type: none"> • Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests. • Troubleshooting Wiring Harnesses. <p>Perform the following:</p> <ul style="list-style-type: none"> • Verify the battery supply voltage to the Steering Assist ECU is between 9 to 18 Volts DC (VDC). • Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear). • Visually check for damaged wiring (at the ECU and the steering gear). • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>. • If the voltage at the ECU is within normal range and the DTC is still active, the ECU will need to be replaced.

Table 2 – Service Action Codes

If any error returns, contact technical support by email at serviceweb@rh-sheppard.com or by phone at 1-800-274-7437. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. **DO NOT** attempt to diagnose J1939 DTCs without the engine running.

Service Action Code	Recommended Service
C	<p>If this Diagnostic Trouble Code (DTC) is continuously active and is unable to be cleared, this is an indicator of an internal malfunction in the Electronic Control Unit (ECU). The ECU must be replaced. If this DTC is intermittent and/or inactive, this is an indication of a battery supply issue.</p> <p>Possible causes: If the supply voltage drops below 9 Volts DC (VDC) during startup, an internal fault may display.</p> <p>Review the following sections:</p> <ul style="list-style-type: none"> • Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests. • Troubleshooting Wiring Harnesses. <p>Perform the following:</p> <ul style="list-style-type: none"> • Verify the battery supply voltage to the Steering Assist ECU is between 9 to 16 VDC. • Cycle the ignition on/off/on and recheck the DTCs. • If the voltage remained above 9 VDC and the DTC is now inactive, verify there is no physical damage to the coil connector. • If there is no damage to the coil connector, check the Steering Assist wiring harness. <ul style="list-style-type: none"> • Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear). • Visually check for damaged wiring (at the ECU and the steering gear). • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.
D	<p>This DTC may not be an indicator of a malfunctioning ECU.</p> <p>Possible causes: These DTCs result from wiring harness issues as measured at the Steering Assist ECU from the steering gear.</p> <p>Review the following sections:</p> <ul style="list-style-type: none"> • Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests. • Troubleshooting Wiring Harnesses. <p>Perform the following:</p> <ul style="list-style-type: none"> • Check the coil in the steering gear. The resistance measured at the coil connector on the steering gear should be 1 - 5 Ohms. If the resistance is not within the normal range, replace the steering gear. • Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear). • Visually check for damaged wiring (at the ECU and the steering gear). • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>. • If the coil measurement is within specification and all of the wiring is trouble-free, the ECU will need to be replaced.
E	<p>This DTC may not be an indicator of a malfunctioning ECU.</p> <p>Possible Causes: The Steering Assist ECU is indicating that parameters in the ECU are missing or incorrect. Whenever an ECU is replaced, this DTC will be active until the pressure trimming and coil polarity tests are conducted through Bendix® ACom® Diagnostic Software.</p> <p>Perform the following:</p> <ul style="list-style-type: none"> • Open the ACom utility and run the pressure trimming and coil polarity tests (details on how to perform this procedure are available in ACom). • If the pressure trimming and coil polarity tests complete successfully and the issue is still not corrected, the ECU will need to be replaced.

Table 2 – Service Action Codes

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NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. **DO NOT** attempt to diagnose J1939 DTCs without the engine running.

Service Action Code	Recommended Service
F	<p>This Diagnostic Trouble Code (DTC) may not be an indicator of a malfunctioning Electronic Control Unit (ECU).</p> <p>Possible Causes: The Steering Assist System has not received the J1939 signal(s) it is expecting from one or more sources. This could be accompanied by other active DTCs from the same source. Some examples of components, cameras, or switches that produce J1939 signals are brake pressure switches; Steering Angle Sensors (SAS); lighting indicators (high/low beam lights, turn signals); windshield wiper status; various engine torque signals; braking or collision mitigation system components; and Wheel Speed Sensors (WSS).</p> <p>Review the following sections:</p> <ul style="list-style-type: none"> • Serial Data (J1939) Troubleshooting Procedure. <p>Perform the following:</p> <ul style="list-style-type: none"> • Check the engine, cab/body controller, or Antilock Braking System (ABS) for DTCs using the manufacturer's diagnostic procedures. The controller that broadcasts the error signal must be investigated first; however, the origin of the signal could potentially be another source. <i>Refer to Table 3 for more information.</i> • After investigating the possible causes, clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.
G	<p>This DTC may not be an indicator of a malfunctioning ECU.</p> <p>Possible Causes: The Steering Assist System has received J1939 signal(s) it is expecting; however, the values indicated that there is a malfunctioning component. Some examples of components, cameras, or switches that produce J1939 signals are brake pressure switches; SAS; lighting indicators (high/low beam lights, turn signals); windshield wiper status; various engine torque signals; braking or collision mitigation system components; and WSS.</p> <p>Perform the following:</p> <ul style="list-style-type: none"> • Check the engine, cab/body controller, or ABS for DTCs using the manufacturer's diagnostic procedures. The controller that broadcasts the error signal must be investigated first; however, the origin of the signal could potentially be another source. <i>Refer to Table 3 for more information.</i> • After investigating the possible causes, clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.
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DO NOT attempt to diagnose J1939 DTCs without the engine running.

Service Action Code	Recommended Service
H	<p>This Diagnostic Trouble Code (DTC) may not be an indicator of a malfunctioning Electronic Control Unit (ECU).</p> <p>Possible Causes: These DTCs may result from wiring harness issues as measured at the Steering Assist ECU from the steering gear, issues with the pressure sensor on the steering gear, or issues with the ECU.</p> <p>Review the following sections:</p> <ul style="list-style-type: none"> • Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests. • Troubleshooting Wiring Harnesses. <p>Perform the following:</p> <ul style="list-style-type: none"> • Check the voltage at the pressure sensor connector. <ul style="list-style-type: none"> • Unplug the connector for the pressure sensor at the steering gear. • Measure the voltage on the pressure sensor harness from Pin 3 to Pin 5. The voltage should be between 0.5 - 4.5 Volts DC (VDC). • Measure the voltage on the pressure sensor harness from Pin 4 to Pin 5. The voltage should be between 0.5 - 4.5 VDC. • If the voltage is within the normal range, replace the pressure sensor on the steering gear (replacement kit part number 0992564K). • If the voltage is not within the normal range, plug the pressure sensor back in and check the voltage at the ECU. <ul style="list-style-type: none"> • With the ECU connected, measure the voltage from Pin 1 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned. • With the ECU connected, measure the voltage from Pin 2 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned. • If the voltage is within the normal range, the ECU will need to be replaced. • If the voltage is not within the normal range, check the wiring harness. • Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear). • Visually check for damaged wiring (at the ECU and the steering gear). • If the wiring is trouble-free, the ECU will need to be replaced. • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.

Table 2 – Service Action Codes

If any error returns, contact technical support by email at serviceweb@rh-sheppard.com or by phone at 1-800-274-7437. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds.
DO NOT attempt to diagnose J1939 DTCs without the engine running.

Service Action Code	Recommended Service
J	<p>This Diagnostic Trouble Code (DTC) <i>may not</i> be an indicator of a malfunctioning Electronic Control Unit (ECU).</p> <p>Possible Causes: These DTCs may result from wiring harness issues as measured at the Steering Assist ECU from the steering gear, issues with the wiring harness as measured at the Steering Assist ECU from the steering gear, or pressure sensor failure.</p> <p>Review the following Sections:</p> <ul style="list-style-type: none"> • Relief Plunger Adjustment video on rhsheppard.com (<i>select the Customer Service tab and Sheppard Service and Instructional Videos</i>). • Troubleshooting Diagnostic Trouble Codes: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests. • Troubleshooting Wiring Harnesses. <p>Perform the following:</p> <ul style="list-style-type: none"> • Reset the relief plungers following the procedure in the Relief Plunger Adjustment video on rhsheppard.com. • Check the voltage at the pressure sensor connector. <ul style="list-style-type: none"> • Unplug the connector for the pressure sensor at the steering gear. • Measure the voltage on the pressure sensor harness from Pin 3 to Pin 5. The voltage should be between 0.5 - 4.5 Volts DC (VDC). • Measure the voltage on the pressure sensor harness from Pin 4 to Pin 5. The voltage should be between 0.5 - 4.5 VDC. • If the voltage is within the normal range, replace the pressure sensor on the steering gear (replacement kit part number 0992564K). • If the voltage is not within the normal range, plug the pressure sensor back in and check the voltage at the ECU. <ul style="list-style-type: none"> • With the ECU connected, measure the voltage from Pin 1 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned. • With the ECU connected, measure the voltage from Pin 2 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned. • If the voltage is within the normal range, the ECU will need to be replaced. • If the voltage is not within the normal range, check the wiring harness. • Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear). • Visually check for damaged wiring (at the ECU and the steering gear). • If the wiring is trouble-free, the ECU will need to be replaced. • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.
K	<p>This DTC <i>is</i> an indicator of an internal malfunction in the ECU. The ECU must be replaced.</p>
M	<p>This DTC is an indicator that the parameters specific to the steering gear have not be programmed properly or that the parameters have been erased due to an error. The ECU must be replaced.</p>

Table 2 – Service Action Codes

If any error returns, contact technical support by email at serviceweb@rh-sheppard.com or by phone at 1-800-274-7437. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. **DO NOT** attempt to diagnose J1939 DTCs without the engine running.

Service Action Code	Recommended Service
N	<p>This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning Electronic Control Unit (ECU).</p> <p>Possible Causes: The ECU may have lost battery power during the shutdown sequence.</p> <p>Perform the following:</p> <ul style="list-style-type: none"> • Cycle the ignition on/off/on. • Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>. • If the DTC is set to inactive and can be cleared by the above step, the ECU is functioning properly and the system can be returned into operation. • If the DTC stays active and is unable to be cleared, the ECU will need to be replaced.
P	<p>This DTC is not an indicator of a malfunctioning ECU.</p> <p>Possible Causes: Information from the camera may not be correct.</p> <p>Perform the following:</p> <ul style="list-style-type: none"> • Refer to the camera manufacturer's diagnostics to troubleshoot for proper lane detection. • Recalibrate the camera.

Table 2 – Service Action Codes

If any error returns, contact technical support by email at serviceweb@rh-sheppard.com or by phone at 1-800-274-7437. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

PIN IDENTIFICATION

See Figure 8 and refer to Table 3 for the connector pins for the Steering Assist Electronic Control Unit (ECU).

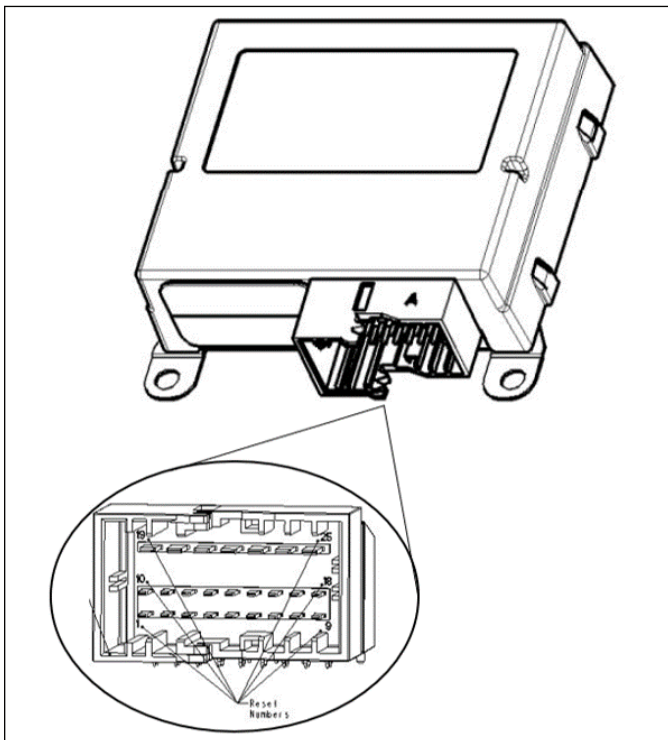


Figure 8 – Steering Assist ECU Connector Pins

Pin Number	Description
1	Left Pressure Signal
2	Right Pressure Signal
3	Pressure Sensor Ground
4	Pressure Sensor Supply
5	—
6	—
7	—
8	—
9	—
10	J1939 Low
11	J1939 High
12	Private Communication Low
13	Private Communication High
14	—
15	—
16	Coil Supply A
17	Coil Supply B
18	—
19	—
20	Ignition
21	—
22	Module Power 12V
23	—
24	—
25	Ground GND (-)

Table 3 – Steering Assist ECU Connector Pins

See Figure 9 and refer to Table 4 for the connector pins for the pressure sensor.

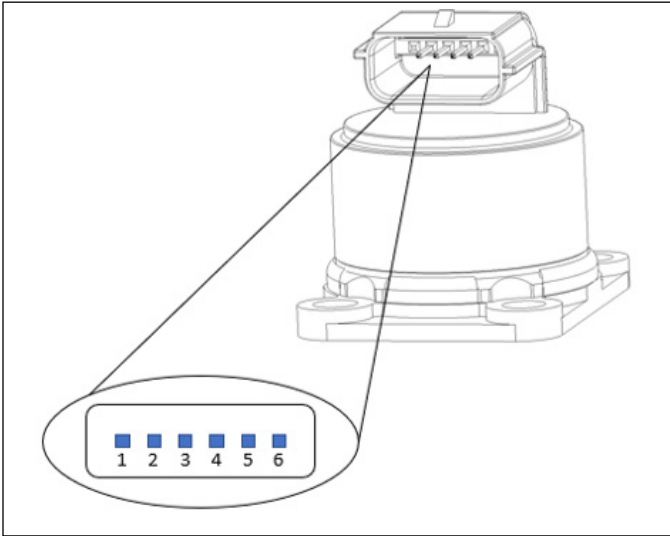


Figure 9 – Pressure Sensor Connector Pins

Pin Number	Description
1	—
2	Pressure Sensor Supply
3	Pressure Sensor Right
4	Pressure Sensor Left
5	Pressure Sensor Ground
6	—

Table 4 – Pressure Sensor Connector Pins

See Figure 10 and refer to Table 5 for the connector pins for the coil.

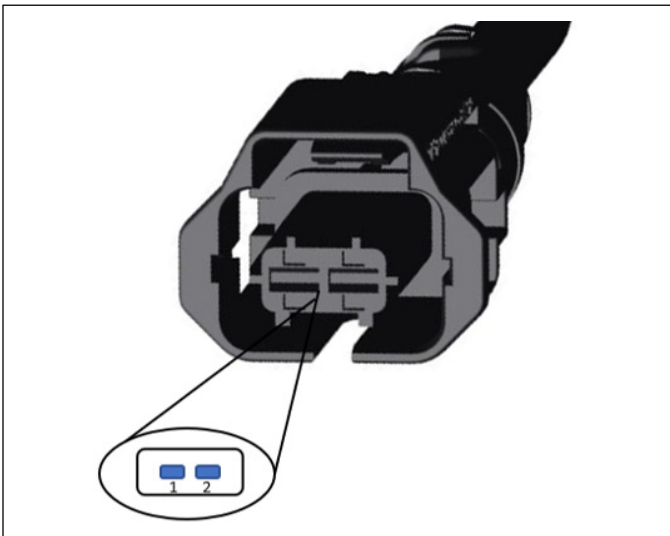


Figure 10 – Coil Connector Pins

Pin Number	Description
1	Coil Supply A
2	Coil Supply B

Table 5 – Coil Connector Pins

PRESSURE SENSOR, COVER, AND GASKET REPLACEMENT

If a pressure sensor has been identified as faulty or damaged, it must be replaced. Once the faulty or damaged pressure sensor is removed, follow the steps below for the installation of the new sensor.

1. Align the gasket and pressure sensor with the half circle cut-out in each part. See Figure 11.
2. Align the pressure sensor and gasket on the bearing cap. See Figure 11.
3. Hand start and torque the front right and back left pressure sensor bolts to 13-16 ft-lb (17.6-21.7 N•m) with the 5-mm hex (Allen®) bit. See Figure 11.
4. Remove the alignment fixture (if used) and install the pressure sensor cover by aligning the bottom tabs with the open bolt holes. See Figure 12.
5. Hand start and torque the front left and back right bolts to 13-16 ft-lb (17.6-21.7 N•m) through the tabs of the pressure sensor cover with the 5-mm hex (Allen) bit. See Figure 12.

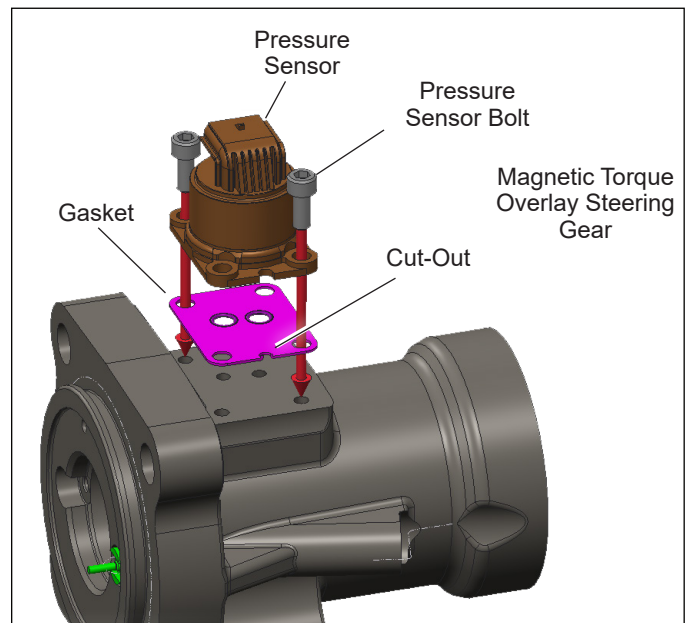


Figure 11 – Pressure Sensor and Gasket

MAGNETIC TORQUE OVERLAY STEERING GEAR AND ELECTRONIC CONTROL UNIT (ECU) REPLACEMENT

NOTE: When replacing the steering gear, the ECU must be matched to the gear at the factory. If ordering the ECU only, please provide the gear serial number and vehicle VIN so the ECU can be flashed at the factory to match. When purchasing a new steering gear, you must order a new steering gear *and* ECU set. The replaced ECU and steering gear must be returned through Bendix to receive core charge credit.

IMPORTANT

The Magnetic Torque Overlay steering actuator is not a "bolt-on" device to the Sheppard™ HD94™ or MD83™ steering gear. The valve inside the HD94-based steering gear is different than the valve in a standard HD94 or MD83 Recirculating Ball Gear (RCB) set. You cannot unbolt the Magnetic Torque Overlay actuator and bolt it onto an off-the-shelf HD94 or MD83 base gear. The Magnetic Torque Overlay steering set is a gear-actuator combo that is shipped as an integrated unit and has a single part number for the integrated assembly.

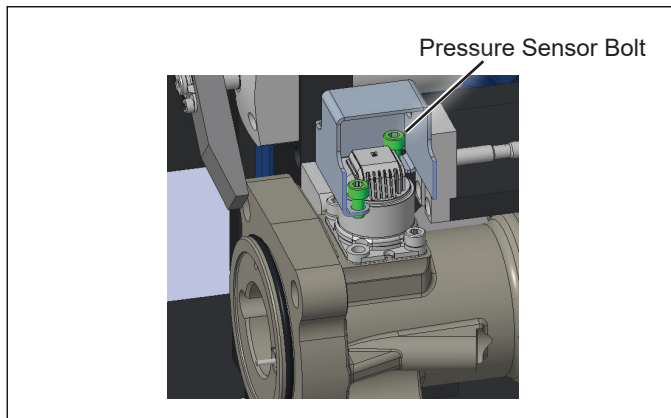


Figure 12 – Bolt Installation

TORQUE OVERLAY POWER STEERING GEAR

Perform a visual inspection to ensure proper installation and functionality. The power steering gear with torque overlay should be clean and free of fluid. All connectors around the gear should be connected and secured. See *Figure 13*. For additional service and troubleshooting information, refer to the Sheppard™ D-Series Integral Power Steering Gear manual on RHSheppard.com.

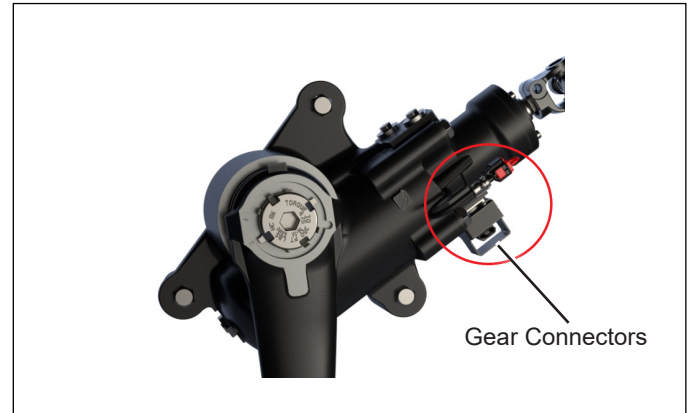


Figure 13 – Gear Connectors

TECHNICAL SUPPORT

Contact technical support by email at serviceweb@rh-sheppard.com or by phone at 1-800-274-7437. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

To purchase and download the Bendix® ACom® Diagnostic Software, visit B2Bendix.com.

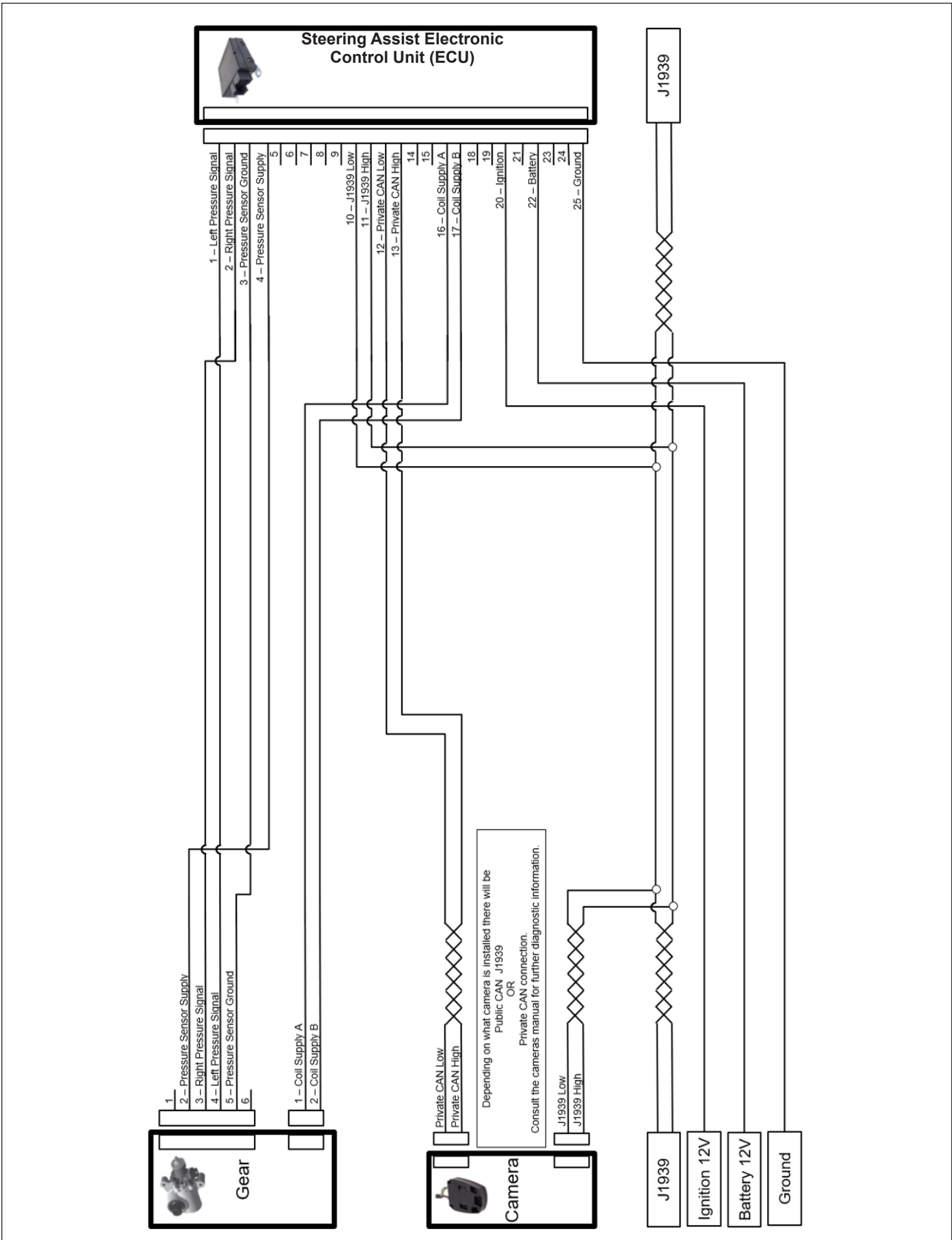


Figure 17 – System Schematic

